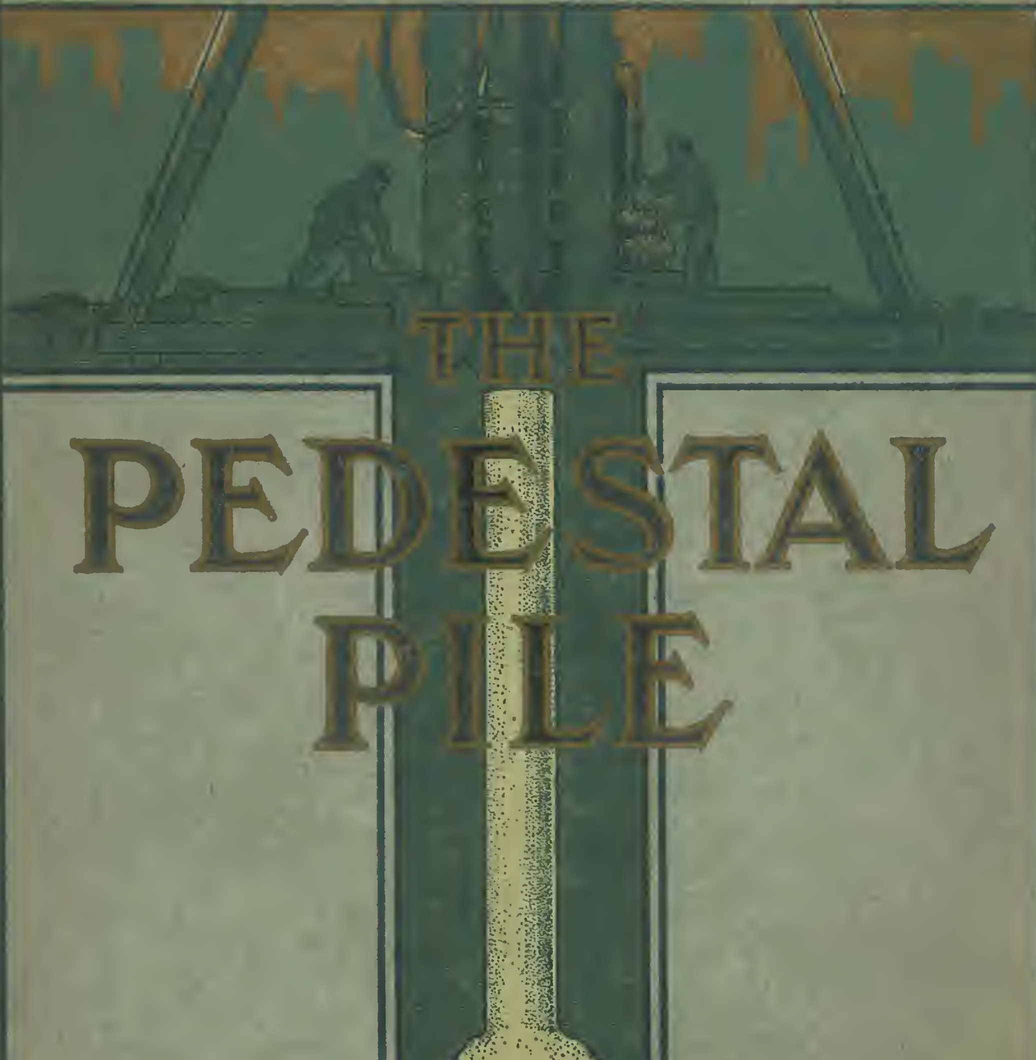
# THE PEDESTAL PILE



MAC ARTHUR
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NEW YORK

*The foot of the Pedestal Pile. This spread base is about 3 feet in diameter and provides from 7 to 8 square feet of bearing area transmitting a direct load to the compacted subsoil. The foot is formed in the ground by a simple process of bulging or mushrooming the concrete out into the surrounding earth.*

# The Pedestal Pile

A BOOK FOR ENGINEERS, ARCHITECTS OWNERS AND CONTRACTORS, DESCRIBING THE PEDESTAL CONCRETE PILE AND DISCUSSING THE RELATIVE MERITS OF WOODEN AND CONCRETE PILES OF VARIOUS TYPES

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The Pedestal Pile is fully
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# The Pedestal Pile

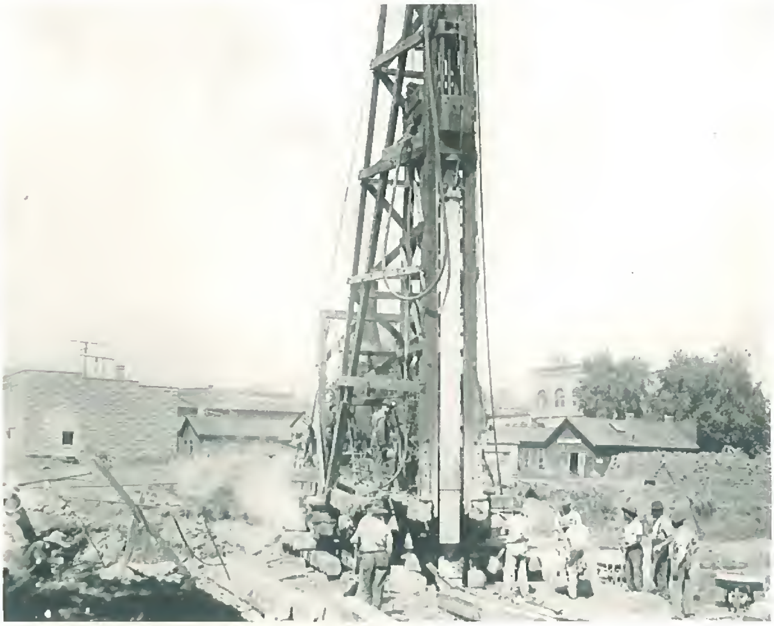
## A DISTINCT ADVANCE IN CONCRETE PILE CONSTRUCTION

PILING has been used by Engineers for more than two thousand years; it is the simplest and most natural means of obtaining firm foundations in soft and unreliable soils. Until recently wooden piles were chiefly used and where kept constantly wet, they have been known to last for hundreds of years. On the other hand, in a great many cases wooden piles have rotted away in a very short time, causing thereby serious settlement and failure of foundations.

Concrete, being impervious to the action of the elements, forms therefore a valuable substitute for wooden piling. Concrete piles, formed and seasoned above ground, or cast down in the ground by various means, have been used to considerable extent both in this country and abroad, and in general have proved an economical and reliable foundation. However, so far as concerns carrying capacity, none of these piles represent any intrinsic improvement over the wooden pile. They are either cylindrical or tapering in shape and support the load imposed upon them in the same way as do wooden piles, i. e., almost entirely by frictional adhesion.

The Pedestal Pile, which is described at some length in the following pages, is a distinct and radical improvement in piling construction. It differs from the ordinary wood or concrete pile in that a large carrying capacity, in addition to that due to frictional adhesion, is derived from the direct bearing power of a

broad base resting in firm and compacted subsoil. The advantage of a pile with a broad base has long been recognized. More than a hundred years ago screw and disk piles were used in England and in the United States. Rankine mentions some cast-iron



*Forming the Pedestal Pile. The top of the casing can be seen protruding from the ground while the core or rammer can be seen hanging in the leads.*

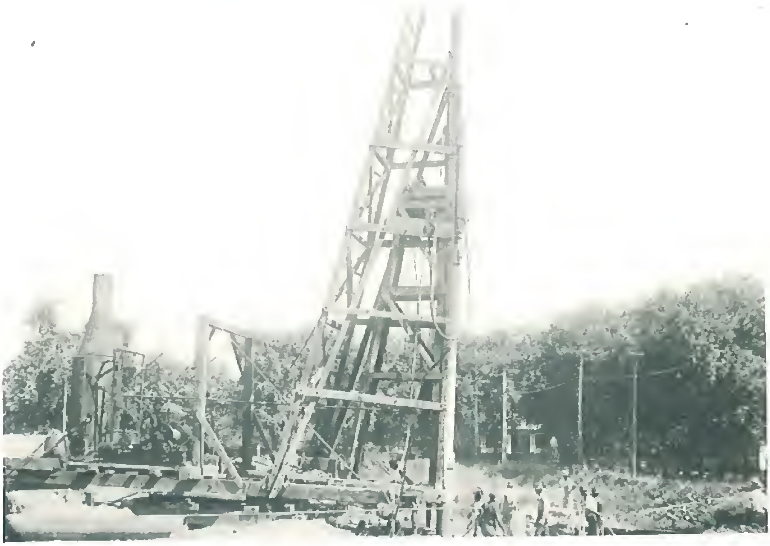
piles, from 20 to 45 ft. long, with screws 2 ft. 6 in. in diameter, which carried a working load of 67 tons per pile without settlement. Evidently the placing of these piles was both laborious and expensive.

It remained, however, for the inventor* of the Pedestal Pile, to devise a method of mushrooming or bulging out this foot in so simple a manner that the completed pile, while capable of supporting large loads, is no more costly than piles of the ordinary type.

*Hunley Abbott.

# FORMATION OF THE PEDESTAL PILE

The apparatus necessary to form the Pedestal Pile consists of a casing and a core. The casing is a steel pipe, 16 in. in diameter and ⅜ in. thick, with outside reinforcing bands, top and bottom. The core is a smaller and longer pipe, with a cast-steel point and an enlarged cast-steel head. The core fits inside the



*The final step in the formation of the Pedestal Pile, the broad base has been bulged out down in the ground and the casing filled with concrete; the casing is now being withdrawn from the ground.*

casing, its enlarged head engaging the top of the casing and its lower pointed end projecting some 4 or 5 ft. below the casing. In the head of the core there is an oak driving block which receives the blows of the hammer. The core is fitted into the casing and both are driven into the ground to the desired depth, as indicated in Fig. 1 on the following page.

The core is then pulled out, and a charge of concrete is dropped to the bottom of the casing, as in Fig. 2. The rammer

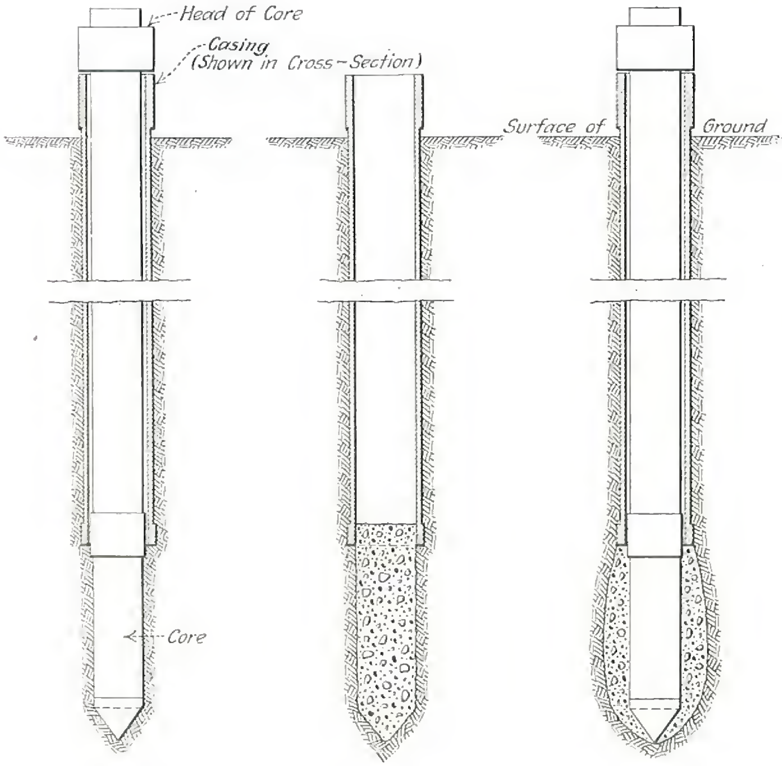



Fig. 1 Fig. 2 Fig. 3

*Fig. (1) A core and cylindrical casing are first driven to the required depth.*

*Fig. (2) The core is now removed and a charge of concrete dumped to the bottom of the casing.*

*Fig. (3) The core is now used as a rammer, to compress this concrete into the surrounding soil. The process is repeated until the base is about 3 feet in diameter.*

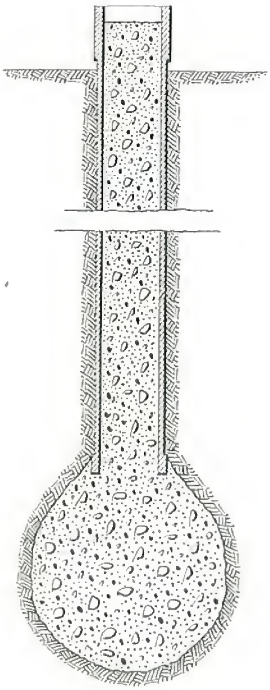


Fig. 4

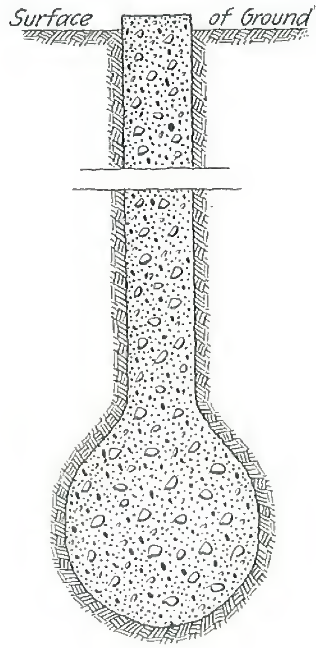



Fig. 5

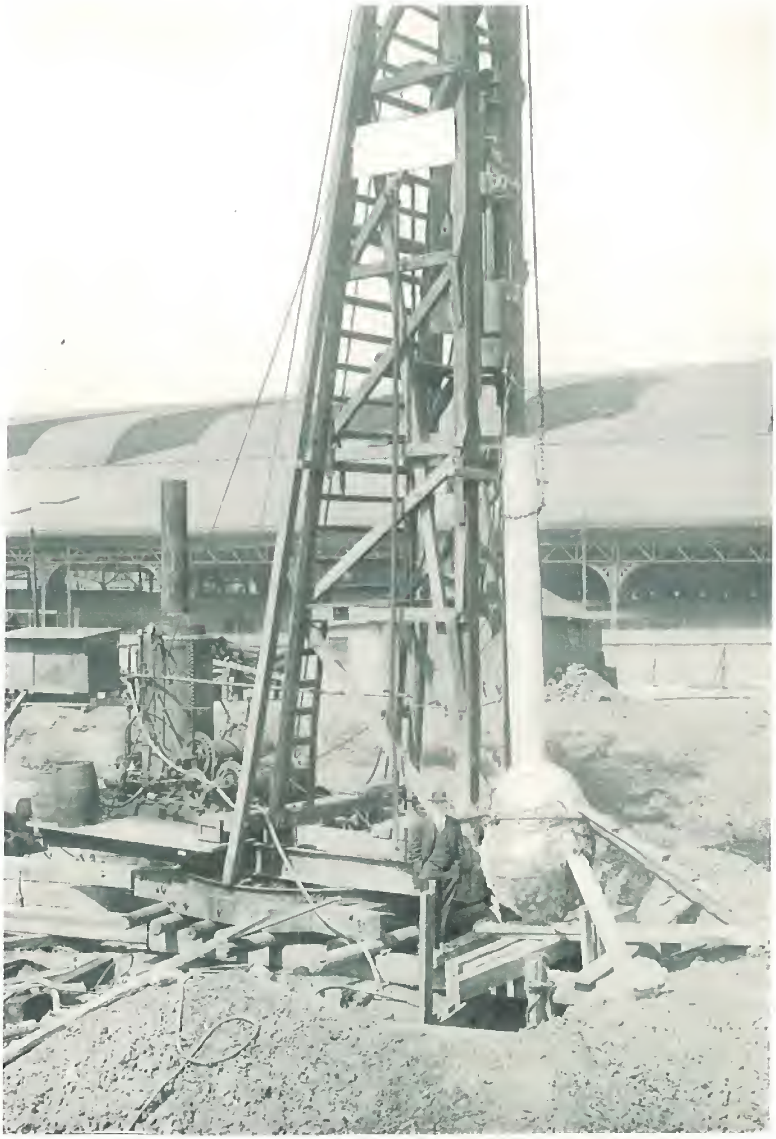
*Fig. (4) The enlarged base being completed the casing is filled to the top with wet concrete.*

*Fig. (5) The final step is to withdraw the cylindrical casing from the ground. The completed Pedestal Pile, consisting of a monolithic concrete column 17 inches in diameter surmounting a broad base 3 feet in diameter, is thus left in the ground.*

is now lowered into the casing and driven down through this concrete, as shown by Fig. 3. As a result the concrete is compressed and is forced out against the soil, pushing back and compacting the surrounding earth. The operation is now repeated. The rammer being withdrawn, another charge of concrete is dropped down inside the shell and the rammer again driven through it, causing the concrete to be forced out still further into the surrounding earth. This process is continued until a sufficient volume of concrete has been rammed down to insure a footing of the desired size. The ram is then removed, the casing is filled to the top with wet concrete and the pile has the form of Fig. 4.

The casing is then removed slowly and evenly, the concrete falling into position and filling out the thin space formerly occupied by the casing. For this reason, after the casing has been completely removed, the surface of the concrete in the shell will be found to have sunk some 3 to 6 ft., according to the length of the pile. The volume of concrete represented by this sinkage has been found to agree exactly with the volume of the casing wall which it replaces. This fact has been confirmed with Pedestal Piles placed in mud, soft clay, trash fills and quicksand, proving conclusively that there is no flowing in of the earth after the casing is withdrawn. The resulting pile is a column 17 in. in diameter with an enlarged base or Pedestal, as shown in Fig. 5 and the photograph on page 13.

The formation of the enlarged base or footing is simple and direct. Little additional labor is required and but small added time. The total time required for the complete formation of the pile is about 30 minutes.



*View of complete Pedestal Pile, dug up for inspection. This pile is cast in the ground, a core and casing being first driven to the required depth, the broad foot being then bulged out at the lower end. The broad base provides great additional carrying capacity.*

# HOW A PILE SUPPORTS ITS LOAD

Where a structure is to be built on soft or unreliable ground, spread footings cannot be depended upon to carry the weight without undue and unequal settlement. Under such conditions, some type of piling is usually found to be the most economical foundation. Piles provide increased carrying capacity by transmitting the load to the firmer and more reliable subsoil underlying the surface soil. A pile develops this carrying capacity in two ways: by the frictional resistance of its surface with the soil penetrated and by the direct bearing of its base upon the subsoil.

In "A Practical Treatise on Foundations," by Patton, the following equation is given for the total carrying capacity of a pile:

$$L = bA + fS, \text{ in which}$$

L=the safe supporting power of the pile,

b=the safe bearing power per sq. ft. of the soil at the point or base of the pile,

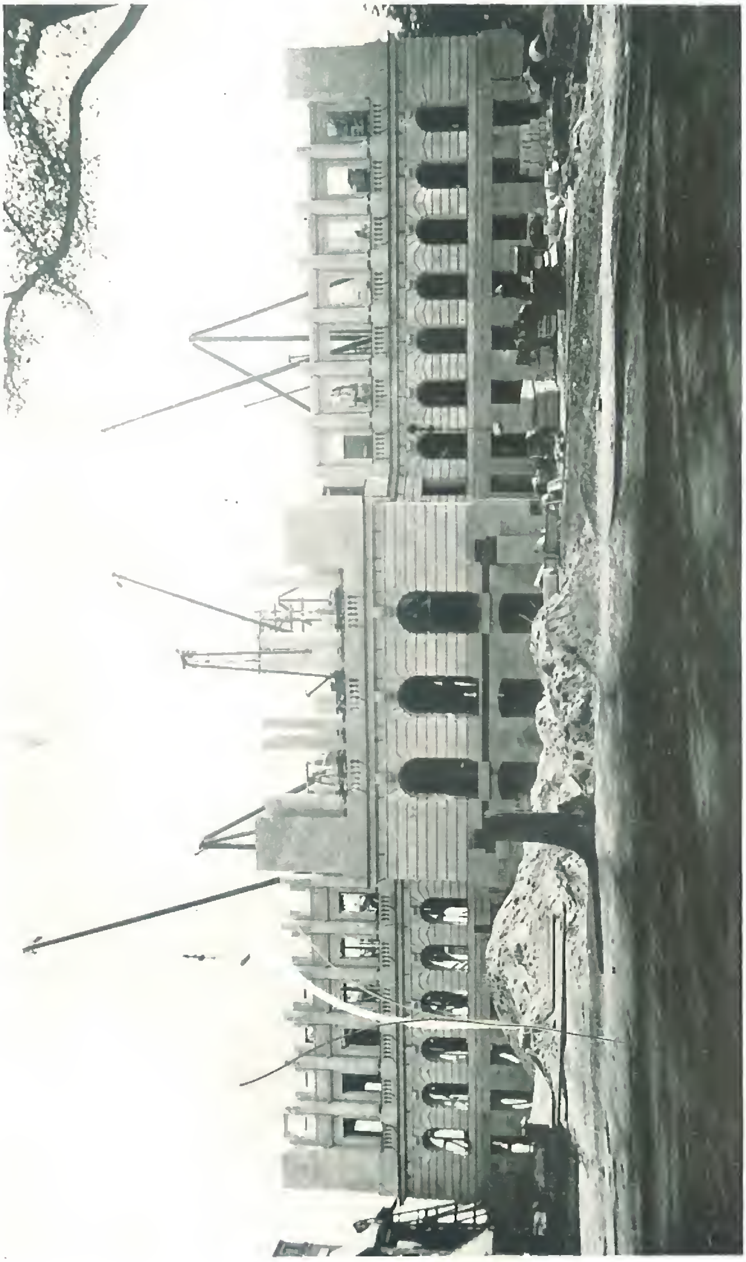
A=the area, in sq. ft., of the base of the pile,

f=the safe frictional resistance per sq. ft. of soil penetrated by the pile, and

S=the number of sq. ft. of surface in contact with the soil.

Patton further states that, as A and S are known from the size and shape of the pile, if we know b and f, we can determine the supporting power of the pile under any conditions. For most cases b, the bearing power of the soil at the foot of the pile, can be quite accurately predetermined, but f, the frictional resistance, is of a somewhat less determinate nature. It ranges in general from 100 lbs. per sq. ft. in the softest soils to 600 lbs. per sq. ft. in compact sand and gravel.

From Patton's equation we can now compute the carrying capacity of different types of piles and compare them with one another. As, however, the conditions existing with single piles and group piles are somewhat different, we shall consider them separately.



*The Bergen County Court House in Course of Erection. This building rests on 900 Pedestal Piles.*

## SINGLE PILES

A straight or tapered pile supports its load almost entirely by friction. The surface area in frictional contact with the earth penetrated is from 50 to 150 sq. ft., depending on the length and shape of the pile, while the area of its base, transmitting a load by direct pressure on the subsoil, is seldom greater than one square foot. With the average wooden pile, the area of the point or base is about .275 sq. ft., and with the ordinary tapered concrete pile it is about the same, while with a large straight concrete pile it may be as much as 1.4 sq. ft.

Because of this small base area, an ordinary pile does not derive much bearing power from the soil at its foot. A plain straight or tapered pile must depend almost entirely on frictional resistance to transmit load to the subsoil, and as natural conditions usually limit this resistance to a low value, the load finally placed upon the subsoil is far less than its safe bearing power.

Regarding the manner in which a pile supports its load by friction, E. P. Goodrich (Trans. A. S. C. E. XLVIII No. 921), points out that "When a pile is supported entirely by frictional resistance, the actual region supporting the load is some deep ground level at which the frictional resistance holding the pile has been transferred through the earth in the shape of a conoid of pressure, the base of which gives a total bearing value equal to the load and a unit bearing value which the earth at that lower level will support. Each kind and degree of compactness will give a different angle for the slope of the conoidal surface."

By assuming the existence of a conoid of earth distributing the pressure from the pile over a broad surface of subsoil, it is possible to explain why a pile supports a fairly large load by frictional resistance alone. Referring to Fig. 6, we see that the pressure transferred by the surface of the pile to the earth penetrated, is in turn transmitted by the cone of earth to a broad area of subsoil. As the depth increases the unit pressure per sq. ft. on the subsoil becomes less and less.

The load transmitted to the subsoil by this conoid is in any case

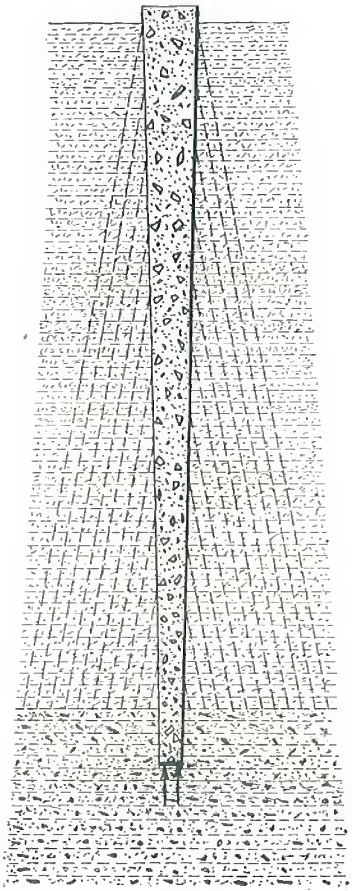


*Fig. 6*

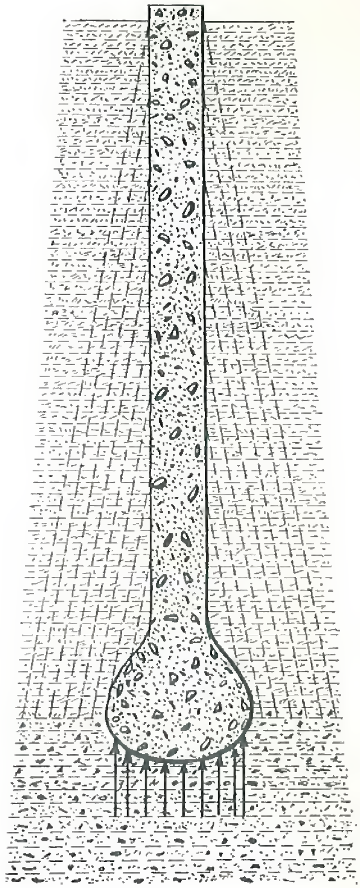


*Fig. 7*

*How an ordinary pile supports its load. The frictional adhesion of the surface of the pile with the earth penetrated is transmitted to the subsoil by a conoid of pressure. The base provides a slight additional carrying capacity due to its direct bearing on the subsoil.*

*How a Pedestal Pile supports its load. The frictional adhesion of the surface of the pile with the earth penetrated is transmitted to the subsoil by conoid of pressure and a large additional load is directly transmitted to the subsoil by the broad base bearing directly on it.*

limited by the frictional resistance between the pile and the earth surrounding it. For instance, a fair load on an ordinary pile is 20 tons. If the pile in Fig. 6 is 30 ft. long and if the conoid of pressure has an angle of 15 degrees, that is, an angle of 7½ degrees with the axis of the pile, corresponding to a certain texture and degree of compactness, the area of the base of the cone, 30 ft. below the surface of the earth will be 63.6 sq. ft. As the total load on the pile is 20 tons, it is evident that at this depth the unit pressure per sq. ft. of subsoil will be only about ⅓ of a ton per sq. ft. The pile therefore develops far less than what is the safe bearing power of the soil even under the most adverse conditions. Again, if we assume that conditions are such that the angle of the cone is only 6 degrees, namely an angle of 3 degrees with the axis of the pile, then the area of the base of the cone, 30 ft. below the surface of the soil, would be about 10 sq. ft. If the pile were again carrying 20 tons load, each sq. ft. of subsoil would then be loaded to two tons. Even this figure is quite low.

It is evident then, that the limitations to loading of an ordinary pile by reason of the small frictional adhesion which can be developed between its surface and the earth penetrated, results in the subsoil being greatly underloaded. Accordingly the most promising method of increasing the carrying capacity of a pile is to make it of such shape that the subsoil surrounding its base is loaded to the fullest extent. *This is accomplished by the broad base of the Pedestal Pile.* The frictional loading is transferred to the subsoil by a conoid of pressure similar to that obtained with the pile in Figure 6 and in addition the subsoil is directly loaded by the pressure of the broad base upon the subsoil.

# THE CARRYING CAPACITY OF A PEDESTAL PILE COMPARED WITH ORDINARY PILES

In order to compare the carrying capacity of ordinary piles with that of the Pedestal Pile a thirty-foot pile under average soil conditions will be considered. The tables on frictional adhesion and direct bearing power given at the end of this chapter, show that under average conditions, a pile would develop 300 lbs. of frictional resistance per square foot of surface in contact with the soil penetrated, and 5 tons direct bearing power per square foot of base area resting on the subsoil.

A wooden pile 30 feet long, 12 inches diameter at its butt and 7 inches diameter at its point or base, would have a frictional surface of 74.5 sq. ft. and as each sq. ft. of surface would provide 300 lbs. of carrying capacity, the total frictional load would be 11.2 tons. Similarly, a pile 17 inches in diameter at its head, 17 inches diameter at the base, and 30 ft. long would have a frictional surface of 133½ sq. ft. and would develop a frictional capacity of 20.0 tons. These figures, as well as figures for the other sized piles are tabulated on the following page.

With a unit bearing value of 5 tons per sq. ft., the wooden pile having a base area of .270 sq. ft. would carry a direct column load due to the pressure of its base upon the subsoil of 1.35 tons. Similarly a straight pile 17 in. in diameter would transmit a direct column load of 7.90 tons. Adding these values to the loading obtained by friction we get the total load carried by a wooden pile as 12.6 tons and by the large straight concrete pile as 27.9 tons. It is to be noted here that the largest straight concrete pile actually used has a diameter of 16 inches. The carrying capacity of a 17 inch diameter pile is figured, so that in comparing it with the Pedestal Pile, the great value of the broad base of the latter may be evident beyond question.

The *frictional* carrying capacity obtained with the Pedestal Pile will amount to as much, if not more, than that provided by a 17 inch diameter straight pile. The column of the Pedestal

# CARRYING CAPACITY OF VARIOUS TYPES OF PILES FOR AVERAGE SOIL CONDITIONS

| Size of Pile | Surface Area, Square Feet | Frictional carrying capacity at 300 lbs. per sq. ft. | Bearing Area at foot or point, sq. ft. | Direct bearing capacity at 5 tons per sq. ft. | Total carrying capacity of Pile |
|---|---|---|---|---|---|
| | | Tons | | Tons | Tons |
| Wooden Pile 30 ft. long. Diameters 12″ and 7″ | 74.5 | 11.2 | .270 | 1.35 | 12.6 |
| Concrete Pile 30 ft. long. Diameters 18″ and 6″ | 94.3 | 14.2 | .205 | 1.03 | 15.2 |
| Concrete Pile 30 ft. long. Diameters 14″ and 14″ | 110. | 16.5 | 1.07 | 5.35 | 21.9 |
| Concrete Pile 30 ft. long. Diameters 16″ and 16″ | 125.7 | 18.8 | 1.395 | 6.96 | 25.8 |
| Concrete Pile 30 ft. long. Diameters 17″ and 17″ | 133.5 | 20.0 | 1.58 | 7.90 | 27.9 |
| **Pedestal Pile** 30 ft. long. Diameters 17″ and 3 ft. | 133.5 | 20.0 | 7.10 | 35.5 | **55.5** |

Pile is 17 inches in diameter, while the base is 3 ft. in diameter. Down to the foot of the Pedestal Pile, the two piles have the same surface area while the zone around the horizontal circumference of the "foot" provides fully as much frictional surface as does the corresponding three foot length of the straight pile. Thus the error in assuming that the total *frictional* resistance developed by the Pedestal Pile is the same as that developed by the straight pile 17 inches in diameter, is unfavorable to the Pedestal Pile rather than otherwise. As was already seen, this *frictional* carrying capacity is 20 tons on a pile 30 ft. long.

Owing to the broad base of the Pedestal Pile, the load supported by direct bearing under the base is usually greater than that supported by friction on the sides. The projected area of the base, corresponding to a diameter of 3 ft., is 7.1 sq. ft. With subsoil capable of carrying a direct load of 5 tons per sq. ft., the total direct load carried by the foot of the Pedestal Pile would be 35.5 tons. This, added to the carrying capacity developed by friction, makes the total carrying capacity of the pile 55.5 tons. For soil in no way favorable to the Pedestal Pile and representing average conditions, it is seen that the Pedestal Pile provides practically twice the carrying capacity of a large straight pile, and more than three times that of the ordinary tapered pile.

These figures which are tabulated in Table I, page 20, are based on average figures for frictional resistance and direct bearing power, as obtained from the following data.

The values given by Patton for the frictional resistance between the earth and the surface of a pile range from 100 lbs. to 600 lbs. per sq. ft., according to the nature of the soil. Corthell, in his "Allowable Pressures on Deep Foundations," gives a summary of a number of actual cases where frictional resistance was measured:

In sinking cylinders for the Papaghni bridge the following frictional resistances were obtained:

In upper sand ................................ ...208-220 lbs. per sq. ft.
In black clay.... ...................................350-560 lbs. per sq. ft.
In silt below clay......................................272-428 lbs. per sq. ft.
In the lower sand .......................................258-316 lbs. per sq. ft.

In sinking cylinders for the Chittrivatri bridge, the frictional resistance was 232 to 377 lbs. per square foot, through 33 feet of sand, 10 feet of clay, and 7 feet of clay and sand clay and boulders. Through 33 feet of sand, 10 feet of clay and 3 feet sand and clay, the frictional resistance was 293-362 lbs. per sq. foot.

At La Rochelle and Rocquefort as reported in the minutes of the meeting of the Institute of Civil Engineers, Vol. L, page 112, the frictional resistance was found to be 164 lbs. per. sq. ft.

In silt at Laurient, 123 lbs. per sq. ft. (Colson notes on Dock Construction.)

In firm sand of good quality, Dutch engineers estimate friction on piles at 614 per sq. ft.

In another portion of the same report a summary of data collected shows that in two cases of cylinder piers, the average frictional resistance was 540 lbs. per sq. ft. Gravel gave the greatest resistance and mud the least.

Twenty-three examples of masonry piers showed an average frictional resistance in sand and gravel of 522 lbs. per sq. ft.

Five examples of walls, quays, and other structures showed an average frictional resistance of 270 lbs. per sq. ft.

*Driving 900 Pedestal Concrete Piles at Hackensack, New Jersey. In the background the men can be seen dumping concrete into the casing.*

From this data it is evident that an assumption of 300 lbs. frictional adhesion per square foot of pile surface is in no way partial to the Pedestal Pile but represents about the average character of soil through which piles are driven.

As will be seen from the following figures a soil capable of producing this frictional resistance would carry a direct column

load of 5 tons per square foot, corresponding to a compact sand or a moderately dry clay. In his book "Allowable Pressures on Deep Foundations," Elmer C. Corthell gives the following summary:

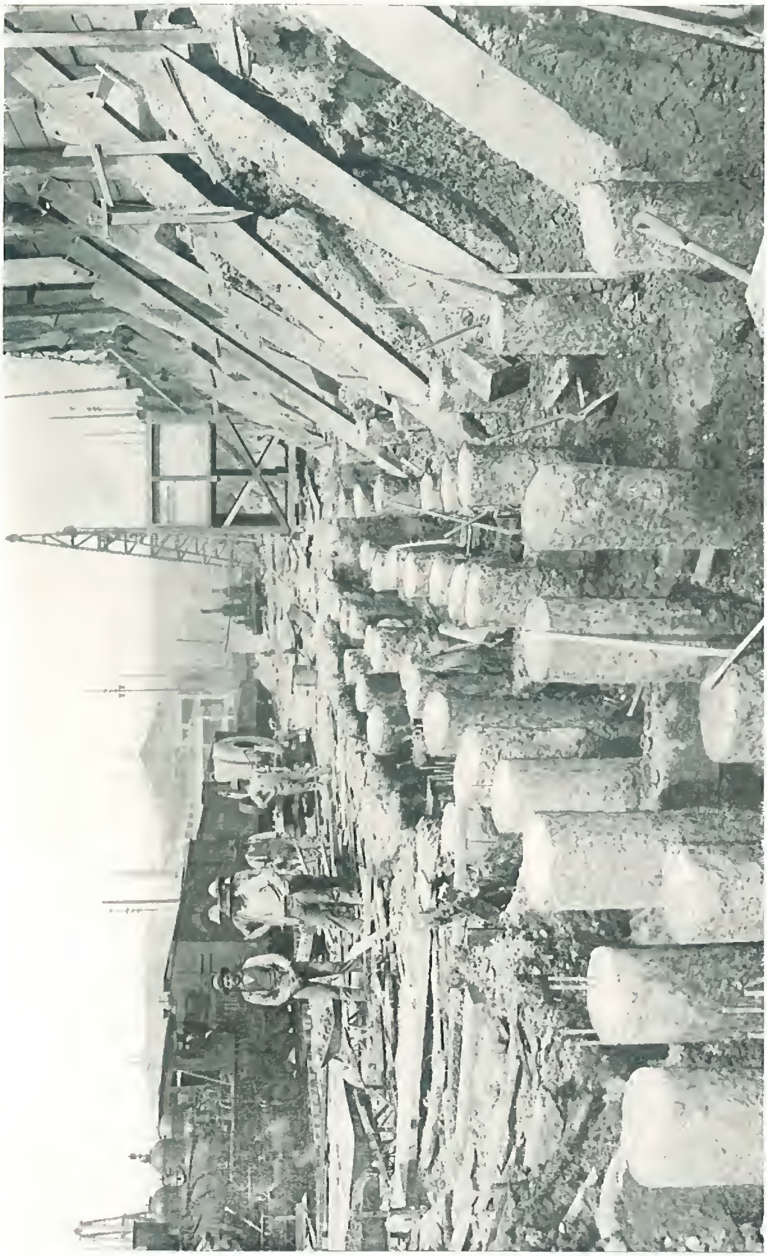
> The pressures of stable structures on fine sand range from 2.25 to 5.80 tons. Average 4.5.
> On coarse sand and gravel 2.4 to 7.75 tons, average 5.1 tons.
> Sand and clay 2.5 to 8.5, average 4.9 tons.
> Alluvium and silt, 1.5 to 6.2, average 2.9 tons.
> Hard Clay, 2.0 to 8.0, average 5.08.
> Hardpan, 3.0 to 12, average 8.7 tons.
> Clay, 4.50 to 5.60, average 5.2 tons.

## SAFE BEARING POWER OF SOILS

IRA O. BAKER

| Kind of Material | Safe Bearing Power. Tons per sq. ft. | | |
|---|---|---|---|
| | Minimum | Maximum | Average |
| Rock, the hardest, in thick layers, in native bed - - - - - | 200 | | |
| Rock, equal to the best ashlar masonry | 25 | 30 | 27.5 |
| Rock, equal to the best brick masonry | 15 | 20 | 17.5 |
| Rock, equal to poor brick masonry | 5 | 10 | 7.5 |
| Clay in thick beds, always dry - | 6 | 8 | 7. |
| Clay in thick beds, moderately dry - | 4 | 6 | 5. |
| Clay, soft - - - - - - | 1 | 2 | 1.5 |
| Gravel and coarse sand, well cemented | 8 | 10 | 9. |
| Sand, dry, compact and well cemented | 4 | 6 | 5. |
| Sand, clean dry - - - - - | 2 | 4 | 3. |
| Quicksand, alluvial soils, etc. - | .5 | 1 | .75 |

It is to be noted that with the Pedestal Pile the direct column load which can be transmitted to the subsoil is somewhat greater than the normal bearing power of the area of subsoil beneath the base of the pile. In the very process of forming the broad base of the pile the soil in that region is compressed and compacted, thereby adding greatly to its normal direct bearing power. A further discussion of this point is given on page 31.



*Several rows of Pedestal Piles partly excavated. The ⅝ inch steel reinforcing used in the columns of these piles can be seen projecting from the tops. These steel rods reinforced the upper 15 feet of the pile against lateral pressure.*

# GROUP PILES

The carrying capacity of a group of ordinary piles depends upon the closeness with which they are driven. The less the distance between their centers, the more the soil between them is compressed and compacted and the more frictional resistance will be developed between the earth and the surface of the piles. Referring to Fig. 8 on the following page we see that when a group of tapered piles are driven into the earth, their load is transferred to the subsoil by the columns of earth between them

*A group of completed piles ready for concrete capping. When Pedestal Piles are placed in groups of this kind, their bases form a continuous footing on the subsoil, thus giving the foundation the strength of a masonry pier.*

and the conoid of earth surrounding the outside of the group. Around the outside of the group of piles, the load on the subsoil depends upon how close the piles are driven and upon the amount of frictional carrying capacity resulting from the adhesion of the pile surface to the earth penetrated.

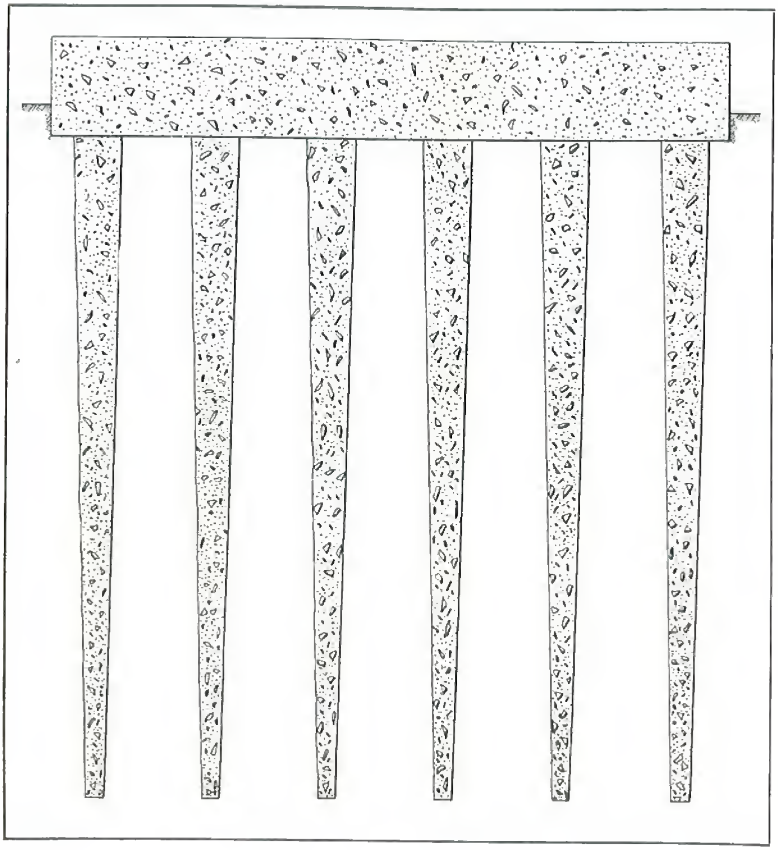


*Fig. (8) A group of ordinary piles driven together. The load supported depends upon the closeness with which they are driven, thus determining the compression of the earth between the piles. Practically all the load is carried by frictional resistance.*

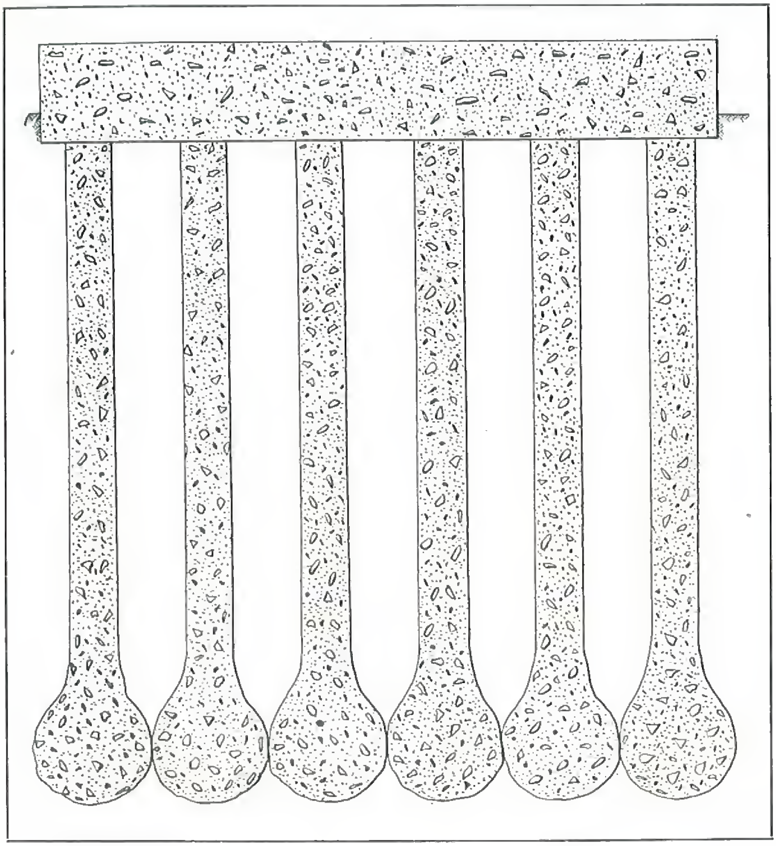


*Fig. (9) A group of Pedestal Piles. The broad bases of the piles run together and form a continuous footing on the subsoil, thus developing the full bearing power of the earth. The strength of this foundation is equivalent to a masonry pier.*


*Sixty-five foot pile drivers at work on a contract for over 70,000 feet of Pedestal Piles.*

The subsoil beneath the first group of piles is loaded by the direct pressure of the base area of the piles, which has already been shown to be practically negligible, especially with tapered piles, and by the pressure of the bases of the columns of earth between the piles. The pressure which these columns of earth can transmit to the subsoil is in turn limited by the loading which the piles can transmit to the earth columns by frictional resistance.

The closer the piles are driven, the more compact the earth between them becomes. Thus the frictional resistance between the pile surface and the earth penetrated is increased, and the more capable are the columns of earth of transferring load to the earth down in the region of their bases.

However, regardless of the number of piles in the group and the closeness with which they are driven, the texture of the earth and the pile surface limits the frictional loading to a low figure. Furthermore, while by reason of the compression of the soil between the piles, the frictional resistance in that region may be somewhat increased, still around the outside of the group no such advantage is obtained.

On the other hand, the carrying capacity of a group of Pedestal Piles is practically equivalent to that of a masonry footing on the subsoil. Fig. 9 shows a group of Pedestal Piles on the same centers as the piles in Fig. 8. The strength of the foundation depends only to a slight degree upon the carrying capacity of the columns of earth between the piles and the frictional resistance of the surface of the piles with the earth. The load is directly transmitted to the firmly compressed subsoil by concrete footings and the full strength of the subsoil is developed around the outside of the group of piles as well as inside. Thus, with a group of Pedestal Piles the load which can be carried is far in excess of the loading possible with a similar group of ordinary piles. Or, looking at the matter from the other point of view, with a small group of Pedestal Piles, as much load can be carried as with a group consisting of two or three times as many ordinary straight or tapered piles.

*The large spead base of the Pedestal Pile. This Pedestal Concrete Pile was formed in soft soil at St. Louis, Mo., and was dug up for inspection. The broad footing enabled the Pedestal Pile to carry the same load as a tapered pile, of nearly twice the length, driven in the same soil.*

# ADDITIONAL CARRYING CAPACITY PROVIDED BY THE BROAD BASE OF THE PEDESTAL PILE

PEDESTAL Piles can carry a far greater load than can ordinary piles because of their broad bases. This additional carrying capacity is large even on sites where, if masonry footings were placed upon the subsoil, the loading capacity would be quite low, because by the use of the Pedestal Pile, the bearing capacity of the soil itself is increased over its natural value. This increase in bearing capacity is due to the compression of the soil in the region of the foot of the pile.

Soils can undergo considerable reduction in volume with an accompanying increase in bearing strength, because, except under heavy pressure, the voids make up a considerable proportion of the total volume. The small particles of earth rest upon the projections and jagged edges of one another, and so do not come into intimate proximity. Under increased pressure or ramming, the particles tend to rearrange themselves, the projections of the one fitting into the hollows in the other. The coming into closer contact of these grains of sand, stone and earth results in a large reduction of the volume of the whole mass, which in turn means an increase in bearing power.

In the first place, the subsoil in the region of the base of a Pedestal Pile is capable of supporting larger loads than surface soil of the same character, by reason of the overlying surface soil itself. "All ordinary soils," says Baker, "will bear more weight the greater depth reached, owing to their becoming more condensed from superincumbent weight." The pressure upon the subsoil, due to the overlying surface soil, will be probably several thousand pounds per sq. ft. at a depth of 20 to 40 ft. and this pressure will tend to compress the soil and further increase its natural bearing power. The direct column load transmitted

## TABLE I. CARRYING CAPACITY OF DIFFERENT TYPES OF PILES. LENGTH, 30 FT.

### CASE I. SUBSOIL, ROCK. SAFE DIRECT BEARING POWER, 15 TONS PER SQ. FT.

| SURFACE SOIL | Friction'l adhesion, pounds per sq. ft. Pounds | Carrying capacity of a Straight Pile, 16″ diameter Tons | Carrying capacity of a Tapered Pile, 18″ diameter at top, 6″ diameter at point Tons | Carrying capacity of a Pedestal Pile, 17″ diameter stem, and 3 foot diameter base Tons | Percentage of Carrying Capacity based on a Pedestal Pile as 100% 16″ Straight Pile | Percentage of Carrying Capacity based on a Pedestal Pile as 100% Tapered Pile 18″ and 6″ |
|---|---|---|---|---|---|---|
| Firm Sand or Gravel | 575 | 56.9 | 30.2 | 144.7 | 39.3% | 20.9% |
| Firm Clay | 450 | 49.1 | 24.3 | 136.3 | 36.0% | 17.8% |
| Sand | 250 | 36.6 | 14.9 | 123.0 | 29.7% | 12.1% |
| Soft Clay, Mud, Alluvium and Silt. | 100 | 27.2 | 7.8 | 113.0 | 24.1% | 6.9% |

NOTE:—In this case the compressive strength of the concrete stem will be the limiting condition and the principal advantage of the Pedestal Pile will be the assurance that the column actually has a broad enough bearing on the rock to transmit its load without crushing.

to the subsoil by the foot of the pile is therefore considerably augmented.

In addition to this increase in strength of the subsoil, there is another and still more important increase in bearing power, due to the fact that in the process of forming the foot of the Pedestal Pile, the soil surrounding and beneath it is greatly compressed. The foot of the Pedestal Pile has a volume of about 16 cu. ft. In forming the foot, therefore, 16 cu. ft. of earth are displaced by the force of the rammer, and hence the volume of the surrounding earth is reduced in like proportion, while the bearing power of the soil is greatly augmented.

Even where the soil displaced by the concrete used to form the footing contains stones or rock of considerable size, great increase in bearing value is still obtained. When a boulder or

*Two views of the foot of an experimental Pedestal Pile. The large irregular projection is a stone which was cemented into the foot.*

TABLE II. CARRYING CAPACITY OF DIFFERENT TYPES OF PILES. LENGTH, 30 FT.

CASE II. SUBSOIL, HARD PAN. SAFE DIRECT BEARING POWER, 10 TONS PER SQ. FT.

| SURFACE SOIL | Friction'l adhesion, pounds per sq. ft. | Carrying capacity of a Straight Pile, 16" diameter | Carrying capacity of a Tapered Pile, 18" diameter at top 6" diameter at point | Carrying capacity of a Pedestal Pile, 17" diameter stem, and 3 foot diameter base | Percentage of Carrying Capacity based on a Pedestal Pile as 100% | |
|---|---|---|---|---|---|---|
| | Pounds | Tons | Tons | Tons | 16" Straight Pile | Tapered Pile 18" and 6" |
| Firm Sand or Gravel | 575 | 49.0 | 29.2 | 109.4 | 44.8% | 26.7% |
| Firm Clay | 450 | 42.2 | 23.3 | 101.0 | 41.7% | 23.1% |
| Sand | 250 | 29.7 | 13.9 | 87.7 | 33.9% | 15.9% |
| Soft Clay, Mud, Alluvium and Silt | 100 | 20.2 | 6.8 | 77.7 | 26.0% | 8.8% |

rock is encountered in forming the foot, the tendency of the concrete is to flow around the obstruction, the rock becoming an integral part of the foot itself. This characteristic of the footing of the Pedestal Pile was shown by a series of tests made on an experimental pile. The illustrations on page 33 show the appearance of the foot of this pile, in which are cemented several large stones. Thus, large sized stones instead of being a hindrance to the bearing power of the foot, only enhance its bearing value, and the soil in other directions is still compressed and compacted, with consequent increase in bearing value.

This increase in bearing power will be of still greater importance with a group of Pedestal Piles than with a single pile. With a single pile, the compression of the soil will be very large in the region immediately surrounding the foot and decrease to a negligible amount at a distance of 5 or 6 feet from the foot. On the other hand with a number of Pedestal Piles acting together in a group, their footings come close

TABLE III. CARRYING CAPACITY OF DIFFERENT TYPES OF PILES. LENGTH, 30 FT.

CASE III. SUBSOIL, DRY CLAY OR GRAVEL. SAFE DIRECT BEARING POWER, 7 TONS PER SQ. FT.

| SURFACE SOIL | Friction'l adhesion, pounds per sq. ft. Pounds | Carrying capacity of a Straight Pile, 16″ diameter Tons | Carrying capacity of a Tapered Pile, 18″ diameter at top, 6″ diameter at point Tons | Carrying capacity of a Pedestal Pile, 17″ diameter stem, and 3 foot diameter base Tons | Percentage of Carrying Capacity based on a Pedestal Pile as 100% | |
|---|---|---|---|---|---|---|
| | | | | | 16″ Straight Pile | Tapered Pile 18″ and 6″ |
| Firm Sand or Gravel | 575 | 45.8 | 28.5 | 88.1 | 52.0% | 32.4% |
| Firm Clay | 450 | 38.0 | 22.6 | 79.7 | 47.7% | 28.4% |
| Sand | 250 | 25.5 | 13.2 | 66.4 | 38.4% | 19.9% |
| Soft Clay, Mud, Alluvium and Silt | 100 | 16.0 | 6.2 | 56.4 | 28.4% | 11.0% |

## TABLE IV. CARRYING CAPACITY OF DIFFERENT TYPES OF PILES. LENGTH, 30 FT.

### CASE IV. SUBSOIL, DRY COMPACT SAND. SAFE DIRECT BEARING POWER, 5 TONS PER SQ. FT.

| SURFACE SOIL | Friction'l adhesion, pounds per sq. ft. | Carrying capacity of a Straight Pile, 16″ diameter | Carrying capacity of a Tapered Pile, 18″ diameter at top, 6″ diameter at point | Carrying capacity of a Pedestal Pile, 17″ diameter stem and 3 foot diameter base | Percentage of Carrying Capacity based on a Pedestal Pile as 100% | |
|---|---|---|---|---|---|---|
| | Pounds | Tons | Tons | Tons | 16″ Straight Pile | Tapered Pile 18″ and 6″ |
| Firm Sand or Gravel | 575 | 43.0 | 28.1 | 74.2 | 58.1% | 38.0% |
| Firm Clay | 450 | 35.2 | 22.2 | 65.5 | 53.8% | 33.9% |
| Sand | 250 | 22.7 | 12.8 | 52.2 | 43.5% | 24.6% |
| Soft Clay, Mud, Alluvium and Silt | 100 | 13.3 | 5.7 | 42.2 | 31.6% | 13.52% |

## TABLE V. CARRYING CAPACITY OF DIFFERENT TYPES OF PILES. LENGTH, 30 FT.

### CASE V. SUBSOIL, SILT, ALLUVIAL SOILS, ETC. SAFE DIRECT BEARING POWER, 2 TONS PER SQ. FT.

| SURFACE SOIL | Friction'l adhesion, pounds per sq. ft. | Carrying capacity of a Straight Pile, 16″ diameter | Carrying capacity of a Tapered Pile, 18″ diameter at top 6″ diameter at Point | Carrying capacity of a Pedestal Pile, 17″ diameter stem and 3 foot diameter base | Percentage of Carrying Capacity based on a Pedestal Pile as 100% | |
|---|---|---|---|---|---|---|
| | Pounds | Tons | Tons | Tons | 16″ Straight Pile | Tapered Pile 18″ and 6″ |
| Firm Sand or Gravel | 575 | 38.8 | 27.5 | 52.6 | 73.7% | 52.3% |
| Firm Clay | 450 | 31.0 | 21.6 | 44.2 | 70.0% | 49.0% |
| Sand | 250 | 18.5 | 12.2 | 30.9 | 60.0% | 38.5% |
| Soft Clay, Mud, Alluvium and Silt | 100 | 9.1 | 5.1 | 20.9 | 43.5% | 24.4% |

to each other so that the compression of the soil due to one foot is met in turn by the compression of the soil due to the adjacent footings and therefore the subsoil receives continuous and practically even compression in all the region beneath the piles. For these reasons, the Pedestal Pile has been able to develop a safe load of 50 or more tons carrying capacity on sites where the surface soil as well as the subsoil was soft mud or similar earth.

However, disregarding the increase in bearing power of the subsoil because of the compression resulting from the formation of the foot of the pile, it is evident from the foregoing tables that, even under the most adverse conditions, the spread base of the Pedestal Pile, by its greater bearing area, practically doubles the carrying capacity of the pile.

These tables are based upon the figures for frictional resistance and direct bearing power given by Baker and Corthell. For the figures on frictional resistance, four average soils have been chosen. Thus in alluvium, soft clay or mud, Corthell's report shows that an average frictional adhesion of about 100 lbs. per sq. ft. can be obtained; with sand, a frictional resistance of about 250 lbs.; with firm clay, a frictional resistance of about 450 lbs.; and in firm sand and gravel, about 575 lbs. per sq. ft. In each table, the frictional carrying capacity of each type of pile is calculated for each of the four soil conditions. At the same time, a subsoil bearing power is assumed and in each table a different subsoil is considered as existing beneath the various surface soils.

The last two columns show the ratio of the carrying capacity of the ordinary straight pile and the ordinary tapered concrete pile to the carrying capacity of the Pedestal Pile. It is noticeable that the carrying capacity of the ordinary, tapered concrete pile is under most soil conditions, less than 30 per cent. of the carrying capacity of the Pedestal Pile.

# THE MAXIMUM CARRYING CAPACITY OF THE PEDESTAL PILE

The total load which can be placed upon the Pedestal Pile is limited by another factor, namely, the compressive strength of the pile itself considered as a column. The diameter of the Pedestal Pile is 17 inches, with a corresponding cross sectional area of 227 sq. in. As concrete has a safe compressive strength of 400 lbs. per sq. in., the safe load that can be placed upon the column of the pile is therefore 227x400 lbs., divided by 2000, equals 45.4 tons. By proper reinforcement this strength can be increased.

Referring to the foregoing tables, it will be seen that the carrying capacity, resulting from the frictional adhesion of the stem of the pile and the direct bearing of the foot of the pile, is in average soils about 40 or 50 tons. Thus, by making the foot of the Pedestal Pile of such size that the total carrying capacity of the pile is 45 tons, a proper balance is obtained between strength and carrying capacity. In other words, the Pedestal Pile provides the maximum carrying capacity with the least waste of material—the size of the foot being sufficient to develop a load which the column of the pile can safely carry in compression. This is to be contrasted with the ordinary pile. The compressive strength of a straight or tapered concrete pile, considered as a column, is far in excess of the load which it can possibly transmit by friction to the soil surrounding it.

# RELIABILITY OF PEDESTAL PILES

WHEN piles are *driven* into place, whether they are of wood or cast and seasoned concrete, it very often happens that the pile is broken or split and the seeming small penetration under the blows of the driving hammer is not a true measure of the strength of the pile. Again, with wood there is a further loss in the power that can be applied to driving due to brooming or splitting away at the top of the pile.

Pedestal Piles are neither driven nor jetted into place, but are formed and cast down in the ground. The core and casing, which are first driven are amply strong to resist breakage. After the casing is in place, a concrete pedestal is formed in place in the ground and its very shape makes it lasting and permanent. The column of concrete surmounting the pedestal is continuous and monolithic with the base so that the completed pile can be relied upon to give the maximum bearing capacity at all times and under all conditions.

*The condition of wooden piling after an attempt to drive to hard bottom. (Courtesy of Cassier's Magazine.)*

*Two Pedestal Piles partly excavated. As can be seen from the photograph, about fifteen feet of loose surface soil was excavated. It is to be noted that the stems of the piles are of full diameter and contain but few irregularities even though the soil in which they were formed was very soft.*

# PERMANENCE OF THE PEDESTAL PILE

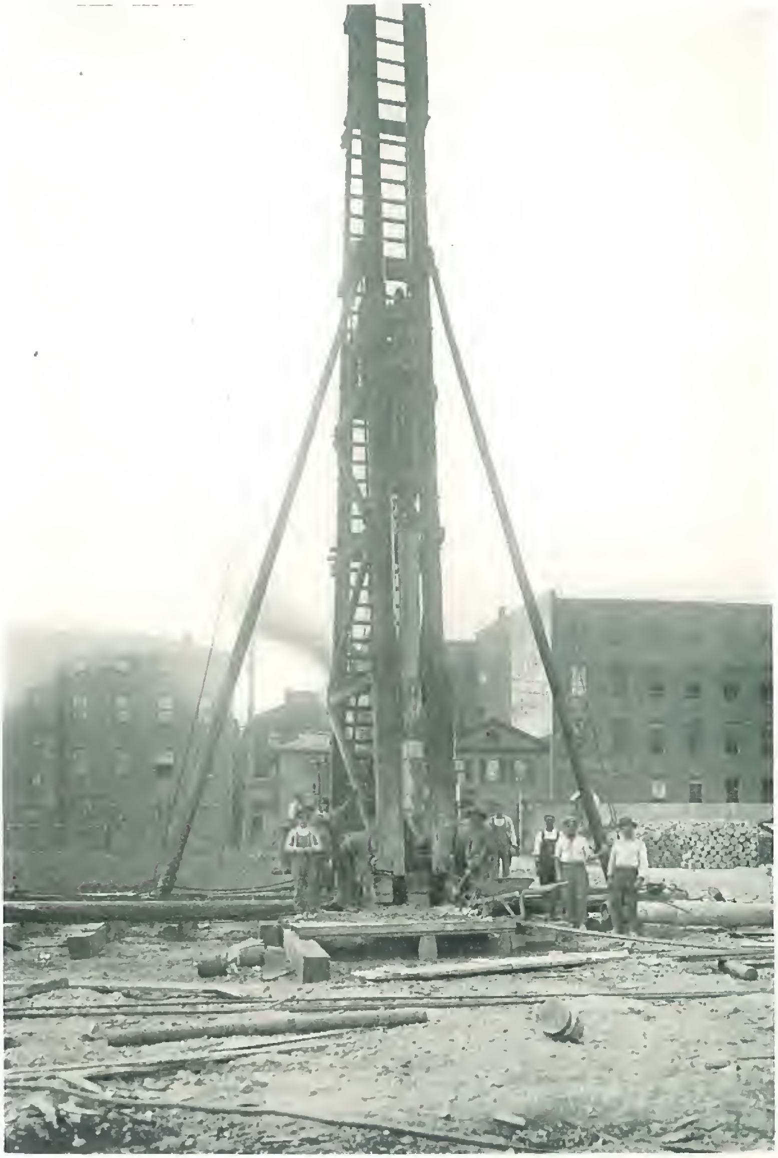
Wooden piles and piles which employ either wood or iron in their construction are liable to wear and corrosion from the action of the elements. Unless a wooden pile be continually submerged in water, it will rot rapidly from alternate wetting and drying. Recently wooden piles on the Pacific coast were found to have a life of only eight months as a result of this rotting action.

So much is to be feared from the weakening of wooden piles by reason of natural rotting that even in places where piles would be placed below the water line, concrete piles are specified. In large cities there is always a likelihood of a future sewer or subway being built in the vicinity of the pile foundations, at which time there will be a lowering of the permanent water line. Under these conditions, if wooden piles were used, the exposed portion would soon rot and thus cause settlement of the foundation. The insurance against such failure obtained by using concrete piles has alone been found to be worth their expense. Again, even where wooden piles are continually submerged, they are liable to decay and rotting if there are certain chemicals in the water or if the water is salt and contains marine borers. Pedestal Piles have no sheet-iron shell or cast-iron point to rust away but are made of the best concrete, properly mixed, and the pile being monolithic, will last an indefinite period.

*Comparison of wood and concrete piling.*

*Wooden pile entirely destroyed by the action of the teredo or marine borer.*

*(Courtesy of Cassier's Magazine.)*



*Forming Pedestal Piles in loose filled earth. The Core or Rammer can be seen hanging in the leads, while the top of the casing can be seen protruding from the ground.*

*Forming 2000 Pedestal Piles for the Oregon and Washington Railroad, at Seattle, Washington.*

# STABILITY OF THE PEDESTAL PILE

The stability of the straight or tapered pile is determined by the resistance offered to lateral movement. The Pedestal Pile affords greater stability than piles of this shape by reason of its broad base. This broad base tends to increase stability in two ways. First, taking a single pile, any tendency to lateral deflection would be resisted by the resistance offered to the side-

*At work on the reinforced concrete capping for the Pedestal Pile foundations of a large Gas Tank.*

wise movement of the stem and the greater frictional resistance at the base which has been rammed and wedged into the soil, as well as the fact that the pile will have to be considerably out of line before the center of loading will fall outside of the broad base. Secondly, when Pedestal Piles are driven in a group, with their tops tied together with a concrete capping and their broad bases run together to form a practically continuous footing on the subsoil, they have the stability of a solid pier. Thus, the resistance to overturning is the same as would be encountered by a masonry foundation on the subsoil.

# TESTS ON PEDESTAL PILES

THE numerous tests made on Pedestal Piles have supported the conclusions concerning carrying capacity already arrived at from theoretical grounds. In discussing the tables given in the foregoing pages, it was pointed out that the Pedestal Pile develops large carrying capacity even where the subsoil is soft, because of the compression of the subsoil around the foot of the pile.

*Testing a Pedestal Pile in the soft muck along the lake front, in the yards of the Lackawanna Steel Co., Buffalo. A single Pedestal Pile supported two and one half times the load carried by an ordinary pile of the same length.*

In no instance has the Pedestal Pile been subjected to a test load on a site where the conditions were such as to give the high-

*Forming Pedestal Piles for an Apartment House in New York City. These piles penetrated a loose surface soil, their broad bases resting directly on hard pan.*

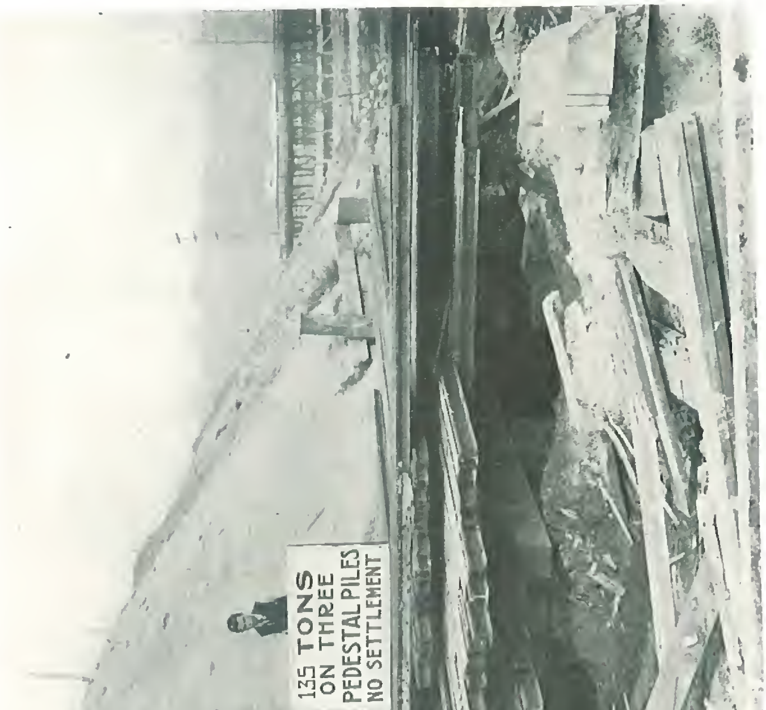

*A remarkable loading test on a short pile. A Pedestal Pile only ten feet in total length carried a load of 45 tons without any settlement.*


*A load of 50 tons on one Pedestal Pile. This pile was formed in a quicksand and soft clay and carried a load of 50 tons without any settlement whatsoever.*

est possible bearing power of the base. On the contrary, the Pedestal Pile has been tested out in soils made of loose trash, mud and quicksand.

Loading tests in the yards of the Lackawanna Steel Co. at Buffalo, N. Y., made in the soft muck along the Lake front, showed that the carrying capacity of a Pedestal Pile was more than 2½ times that of a pile of the same length without the broad base.

The photograph above shows the test load placed upon a single Pedestal Pile at Hackensack, N. J. This pile penetrated sand, quicksand and mud (all very wet and soft). Its end penetrated into soft blue clay. When the pile was about 3 weeks old two tiers of double beams were set at right angles to each other, as shown in the photograph, and a platform built upon these two beams and loaded with carefully balanced cement bags until a load of 50 tons was placed upon the pile. The load remained in position for 24 hours without causing any perceptible settlement whatsoever.




*Remarkable loading tests on three Pedestal Piles. These piles were selected at random and were subjected to a test of 115 tons by the engineers of the Oregon and Washington Railroad. The load was later raised to 135 tons, with no settlement resulting.*

Another interesting test is illustrated on page 46. The Pedestal Pile tested was only 10 ft. in length from the surface of the ground to the bottom of the broad foot. The Pedestal foot being about 3 ft. high, as well as 3 ft. broad, the column of the pile supporting load in friction was only 7 ft. long. Thus, only a very small part of the load was carried by frictional adhesion and practically the whole load of 45 tons was carried by the direct bearing of the broad base on the subsoil. This test proved conclusively the great value of the broad foot of the Pedestal Pile in providing additional loading.

A number of tests made at St. Louis showed that the carrying capacity of a Pedestal Pile 24 ft. long was greater than the capacity of a tapered pile nearly twice that length. On the testing site at St. Louis, the ordinary piles were found to have a capacity of only about 20 tons, whereas the Pedestal Pile was tested out in the same soil and found to resist settlement under a loading of 40 tons. This soil was a cinder and trash fill over very soft clay. The illustration on page 13 shows the pile dug up subsequently to the tests. From this view a very fair idea of the shape of the Pedestal can be obtained.

A test on a group of three Pedestal Piles is shown in the illustration on page 48. These piles were driven into a soft muck and mud overlying a sand subsoil and supported without any settlement whatsoever, the test of 115 tons, put upon them by the engineers of the Oregon & Washington Railroad. The load of 115 tons was later increased to 135 tons, no settlement again being perceptible.

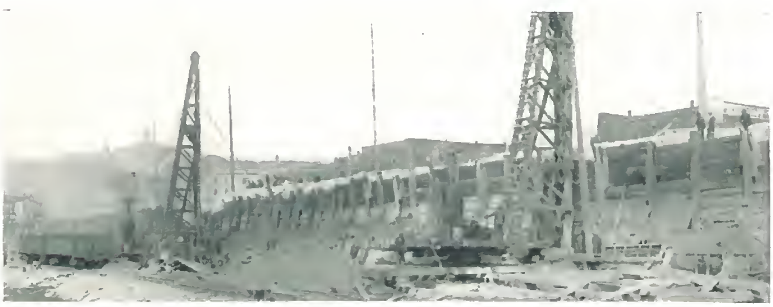
This great carrying capacity could not have been achieved were it not for the broad base of the Pedestal Pile. So, even on sites where soil conditions are not favorable, the Pedestal Pile is capable of carrying a far greater load than is possible with a straight or tapered pile.

## COST OF PEDESTAL PILES

It is impossible to give any exact figures as to the price of Pedestal Piles because this depends so much on the length and number of piles in each job and on many other surrounding circumstances. As a rule, the price will run from $1.00 to $1.25 per linear ft. of piling but very small or very large jobs may run respectively higher or lower than the above figures. In general, the price per linear ft. of the Pedestal Pile is as low or lower than that of any other cast-in-place pile and much lower than that of the cast-above-ground pile.

## ECONOMY OF PEDESTAL PILES

The true comparison of cost comes, however, when the cost per linear ft. is disregarded and the *"cost per ton of load carried"* is considered. We have proven conclusively in the preceding pages and it has been supported by actual observation and test that a Pedestal Pile will carry from 50 per cent. to 100 per cent. more load than any other pile of the same length. In other words, to carry a given structure, it requires only ¾ to ½ as many Pedestal Piles as it does of any other concrete pile. Thus, the owner is able to save from 25 per cent. to 50 per cent. of the cost of his foundations by the use of the Pedestal Pile.



*Forming Pedestal Concrete Piles at Seattle, Wash. About 80,000 feet of piling penetrating mud and muck were placed on this site.*

*Driving Pedestal Piles for the large gas tank of the New Haven Gas Light Co. About 1,000 piles were used for these foundations.*

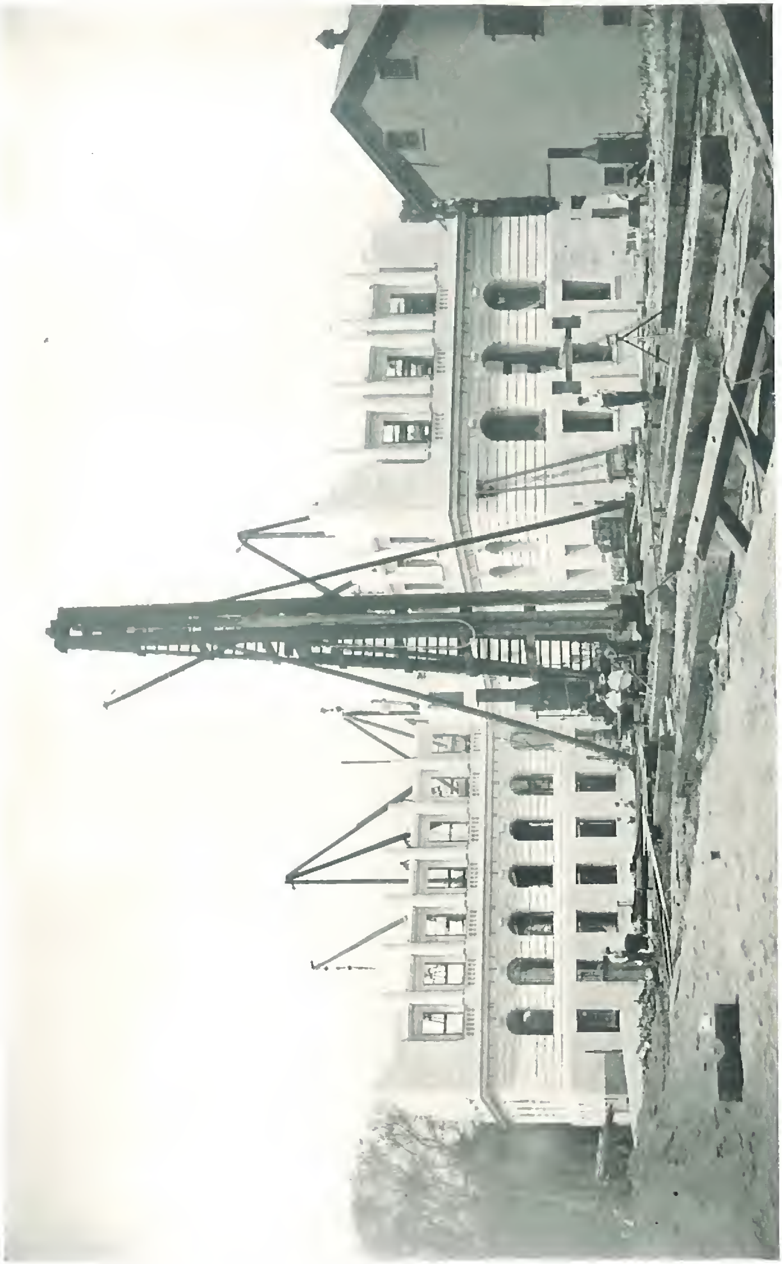
*The pile drivers at work on the foundations of the Bergen County Court House, Hackensack, N. J. The steel core and casing are being driven together to a depth of about 40 feet.*

# PEDESTAL PILES IN FOUNDATION WORK

On the page opposite is illustrated the work on the Bergen County Court House at Hackensack, N. J., where more than 900 Pedestal Piles were used for the foundations. The Court House itself is illustrated on page 15 and is cruciform in plan with extreme dimensions of about 175x200 ft., with four wings about 72 ft. deep. The piles are spaced about 3 ft. apart minimum and 3½ ft. average in rows under the walls and in clusters of from 4 to 8 under the columns. These piles are from 35 to 40 ft. long, most of them penetrating about 7 ft. of fill, 11 ft. of soft, wet, fine sand, 5 feet of quicksand and 14 ft. of soft clay and fine sand and then into a deep bed of soft, wet clay.

The rapidity with which Pedestal Piles can be formed is well

*Assembling pile driving apparatus preparatory to forming Pedestal Pile foundations in the winter season.*



At work on the foundations of the Hackensack Jail, for which about 500 Pedestal Piles were used. The Bergen County Court House, also constructed on Pedestal Pile Foundations, can be seen in the background.

illustrated by the work on this foundation. The casing and core for each pile were driven together in from 8 to 20 minutes by a 3,000 lb. steam hammer, making 60 to 70 thirty-six inch strokes per minute. The Pedestal was then formed in about 10 minutes by the method which has already been discussed, about 6 cu. ft. of concrete being deposited in 4 or 5 charges and rammed into position by the core. The casing was readily pulled by a 10 fold tackle operated by one of the drums of the hoisting engine. This operation required about 3 minutes. The total time on the complete pile averaged about 30 to 40 minutes, including all delays in moving. All this foundation work was not only carried on with exceptional rapidity but was started and completed during the winter season when the ground was frozen to a considerable extent and operations were at times delayed by stormy weather. The record for rapid forming of these piles was 37 forty foot piles in one day, with only two pile drivers. The work was completed ten days before contract time.

The use of Pedestal Piles for the Court House demonstrated so conclusively the economy and great carrying capacity of that type of foundation, that it was also decided to place the contract for the foundation of the Bergen County Jail in the hands of the MacArthur Concrete Pile & Foundation Co. These foundations consist of Pedestal Piles driven on about 3½ ft. centers, about 40 ft. in length, 500 piles being used in all. The photograph on page 54 was taken while the piles were being driven; the building in course of erection in the background is the Bergen County Court House.

The illustration on page 8 shows the foundation work for the U. S. Government Post Office at Paris, Ill. The foundation for this building consisted of 211 Pedestal Piles about 19 feet in length. The soil at the site of this building consisted of 15 to 18 feet of soft clay containing a three-foot layer of quicksand and overlying a bed of hard clay. The piles were driven three feet apart in both directions and as the bases were about three feet in diameter, they practically fused together and formed a continuous footing on the subsoil. This work also was finished ahead of contract time.

The work on the foundations of a twelve story apartment

*At work on the foundations of a large retaining wall, for the Oregon & Washington Railroad. The wooden wall which was replaced by a reinforced concrete wall about 1,600 feet in length, can be seen in the background.*

house in New York City is illustrated on page 45. About 300 Pedestal Piles, 25 ft. in length were formed on this site. The soil in which the piles were placed consists of a surface strata of loose rock and riprap, overlying about 25 ft. of loose mud and soft earth, and beneath this hardpan overlying the bed rock. As can be seen in the illustration, excavation was carried down to a depth of about 25 ft. below the street level, thus reaching the loose soil beneath the riprap. The casing and core for the piles were then readily driven to a depth of about 25 ft., down to solid bottom.

The foundation work for a large retaining wall for the new passenger station of the Oregon & Washington Railroad at Seattle, Washington, is illustrated on the opposite page. The wooden retaining wall, which was replaced by the concrete wall can be seen in the illustration. The foundations consisted of almost 2,000 Pedestal Piles which rest in a loose soil overlying a bed of wet sand. This contract was the largest of its kind ever awarded in the Northwest.

Another typical foundation is that for the gas holder of the New Haven Gas Light Co., work on which is illustrated on page 51. These Pedestal Piles were about 1,000 in number and measured from 10 to 25 feet in length. The piles are placed on 5 foot centers, being distributed evenly throughout the whole area beneath the gas holder. These Pedestal Piles were rapidly placed; in one day 32 ten foot piles, each with its bulged foot were formed with one driver.

*Pedestal Piles have been used for every type of structure. Thousands of piles have been placed in all parts of the United States, as well as in foreign countries. We will be pleased to go into details concerning more recent work, and to aid the engineer, architect or contractor in solving foundation problems of special nature.*

U. S. Government Post Office, Paris, Ill., built on foundations of Pedestal Piles.

# TYPICAL SPECIFICATIONS FOR CONCRETE PILES

The object in writing specifications for foundations is to secure construction that will give the desired supporting capacity together with absolute reliability and if possible indestructibility. The possibilities of different types of piling in this regard have been discussed at some length in the preceding pages. Inasmuch, however, as it often happens that the owner, engineer or architect must draw specifications upon which estimates are received from anyone who may choose to bid, it is highly important that a form of specification be used which, while being fair and impartial to the bidder, shall at the same time insure the best possible construction. With this end in view the following specifications have been drawn up:

## CONCRETE PILES

Piles shall be driven for the foundations as shown on Drawing No. —.

All piles shall be of concrete mixed in the proportions of one of cement, two of sand and four of broken stone, measured by volume.

Stone. All stone for the concrete piles shall be 1 in. diameter or under.

Sand and Cement. As elsewhere specified.

The diameter of all piles shall be not less than 16 inches and they shall have an enlarged foot or bulb at their lower end, having a diameter of about 3 feet.

The length of the piles shall be in general about —— feet, measured from the bottom of the foot to the top of the pile.

Modify the approximate length as may be from time to time directed by the architect, who will keep a record of the measurements from the bottom of the foot to the top of the pile, for comparison with those of the contractors.

The actual length of piling driven shall be determined from the records taken by the architect during the driving of the piles.

# *THE MAC ARTHUR CONCRETE PILE & FOUNDATION CO.*

*a subsidiary company to Mac Arthur Bros. Co., Contractors, is prepared to undertake piling foundations under the Pedestal Pile Patents in any place in North América. Its experience in the problems of forming and designing pile foundations are at the disposal of engineers, architects, owners and contractors, while the reputation and financial status of the Mac Arthur Concrete Pile and Foundation Co. will insure the satisfactory completion and handling of any work.*

*Mac Arthur Bros. Co., Contractors, have been in active operation since the foundation of the business in 1826. Since that time, the following well-known enterprises have been carried on entirely or in part by that firm:*

*Much of the Erie Canal for the State of New York.*

*Many locks and dams in the various states and for the United States Government.*

*Several sections of the Chicago Drainage Canal.*

*World's Fair Grounds, Chicago, 1892-3 and several of the largest buildings.*

*Water Power Canal—Sault Ste. Marie, Michigan.*

*Wachusetts Dam for the city of Boston.*

*West Neebish Channel, Sault Ste. Marie River.*

*Also many thousands of miles of railroads comprised in the principal trunk lines of the United States and Canada, such as:*

*Atchison, Topeka & Santa Fe R. R.*

*Baltimore & Ohio R. R.*

*Chicago & Erie Railroad.*

*Cleveland, Cincinnati, Chicago & St. Louis R. R.*

*Chicago, Burlington & Quincy R. R.*

*Chicago & Alton R. R.*

*Union Pacific R. R.*

*The Virginian Railways and numerous others.*

*Hundreds of thousands of yards of masonry and bridge foundations, buildings and massive structures, extensive harbor and river improvements for the United States Government and recently a large part of the Ashokan Dam.*

*The engineering experience and information, data, results and drawings accumulated in this work are at the disposal of the engineers of the Mac Arthur Concrete Pile & Foundation Co., so that in laying out and carrying through to completion foundations with Pedestal Piles, the builder is assured of the development of the greatest bearing power compatible with soil on the site of the structure, at a minimum of expense.*

*Send us data on soil conditions and blue prints of any proposed structure, and our engineering department will lay out Pedestal Pile foundations suitable for the requirements.*

*We are prepared to send engineers to any portion of the country at our own expense and will undertake and carry to completion Pedestal Pile Foundations in soils of any nature.*

THE GEO. H. GIBSON CO. TRIBUNE BUILDING NEW YORK